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THE VOLCANO KILAUEA.

BY

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This volcano has recently passed through an interesting period of activity, part of which has been under my observation. Before presenting a sketch of these latest phases, I will briefly notice its history, condensing the results of a careful study.

Writers have usually contented themselves with a description of what has happened since the islands have been visited by people of European extraction, about 1820. I have found that the traditions of the natives are capable of giving reliable information about the nature and approximate dates of eruptions for eighteen centuries. Historians have discovered the date when the Hawaiians and Maories separated, because both these races preserved lists of their kings who were the same persons, anterior to the separation. The first emigration to Hawaii was under Wakea in the year 140 A. D. The more important emigration has the date of 1090. The traditions state that, during the entire history of the country, Kilauea has had its periods of activity with an average of one for each reign. Assuming, as is customary, one reign as equivalent to a generation, there would be three reigns and consequently three eruptions for each century, or forty-four since 140.

A few of these eruptions have been especially noted: such as a celebrated conflict between Pele and Tamapua in 1175; another with Kariwari between 1340 and 1380; others later, better characterized. They may be tabulated as follows:

Active at the time of the first immigration.....	140
The same at the second immigration.....	1090
Average of one for each reign: forty-four.....to	1820
Pele's conflict with Tamapua.....	1175+
Pele's conflict with Kariwari.....	1360-1380
In the reign of Liloa.....	1620
In the reign of Arapai, at Kaimu.....	1740
Eruption west of Kapoho.....	1788
Keouas army destroyed.....	1790

Of these the eruption of 1620 seems to have been of the explosive kind, more violent than that of 1790.

Posterior to 1820 the following have been the dates of the most important discharges of lava :

DATE.	PLACE OF DISCHARGE.
1823 Between March and June.....	To the Southwest; reaches the sea.
1832 June 20	Subterranean.
1840 May 30	To the Northeast; reaches the sea.
1849 May	Subterranean.
1855 October	Subterranean.
1868 April 2	To the Southwest; reaches the sea.
1877 May 21	Overflow at Keanakakoi.
1879 April 21	Subterranean.
1884 Jan. 22	Submarine, off Puna.
1886 March 7	Subterranean.
1891 March 7	Subterranean.
1894 July	Subterranean.
1902 Sept. 12	Subterranean.
1908 Sept. 4	Subterranean.

I will mention three points of interest. First: What is called an eruption consists in the accumulation of melted matter, which falls away when the sustaining walls are inadequate to support the liquid. The lava may break through the side of the mountain and flow to the sea, or may reach the bottom of the ocean before the discharge, or there may be a collapse in the interior of the caldera, when the liquid will disappear to parts unknown, beneath the surface. After this collapse the fire usually returns slowly, increasing in amount till it is time for another discharge.

Second: Besides the accumulation of lava, there is an ascensive column, best seen between 1886 and 1894, when a mass of cooled lava rose bodily higher than the accompanying liquid. It was spoken of by some as a mass of rock resting upon a liquid floor, elevated a foot or less daily according to the amount of pressure exerted from beneath. This column must have had a length of several hundred feet. It is comparable with the Spine of Pelé at Martinique, preserved by its enclosure within the walls of Halemaumau, disappearing when its foundation gave way, being like a piston rod moving inside of a cylinder.

Third: Since 1823 the molten lava has attained greater altitudes just before the times of each collapse, chiefly because the cooled basalt has formed a hollow cone of less diameter, so that the same amount of fluid must rise higher in the later periods. Where at first there was an immense pit, a basaltic cone occupies the space; the caldera is slowly filling up.

The supreme event in the history of Kilauea was the presence of a lake of liquid lava at the end of the ascensive column in 1894.

This attained the altitude of 3,755 feet above the sea, 285 below the Volcano-house, with an area of 13.67 acres, as represented in Fig. 1; it is seen to have a border consisting of the cooled edges, substantial enough to keep the liquid within bounds, shaped like an inverted saucer. The molten lava came from below, just as water would fill a barrel through a pipe; and both fluids alike overflowed their receptacles. In 1896, after the lava disappeared interiorly, there was left a cylindrical opening 1,500 feet in diameter, 900 or more feet deep, which is known as Halemaumau, *the fixed, everlasting house*. From time to time this pit shows lava in its depths, accumulating and discharging without any apparent law.

What may be regarded as the beginning of the present activity commenced at the end of November, 1907; a little lava appeared at

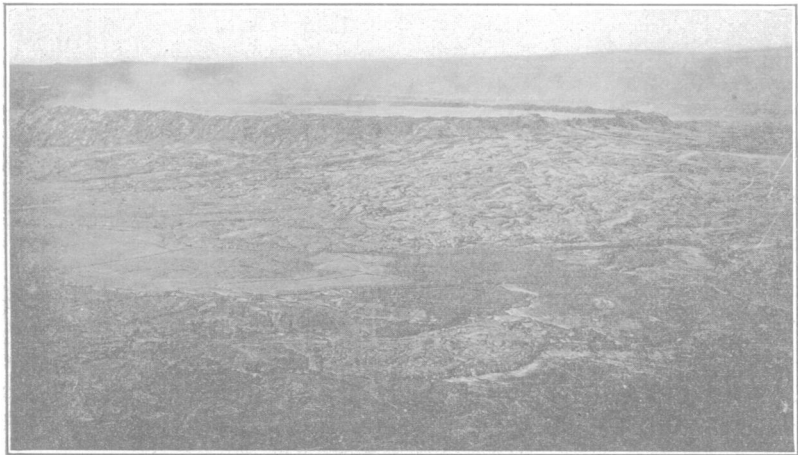


FIG. 1.—KILAUEA. ERUPTION OF 1894.

the bottom of the pit after a quiet of seven months. Early in December the base was encircled by a black ledge, 450 feet down in which was a lower pit 200 feet wide, showing fire 80 feet lower. In the latter part of March, 1908, the pit was estimated to be 1,800 feet in diameter, 300 feet deep, with a spiracle in one corner spouting noisily, and occasionally blowing off its head. The *spiracle* is what early observers have called a blowhole or blowing cone, receiving its name from G. Poulett Scrope, after Italian examples.

On May 26 the pit was estimated to be 200 feet deep, and the molten lake 800 by 700 feet, with a crescent-shaped island in the middle, 75 feet long. After each outburst of gas a tremendous suction draws lava from a radius of 100 feet into a maelstrom; cakes of

lava fifteen to twenty feet in diameter turn upon their edges and disappear. Upon the north side a great spring pours lava out copiously.

On June 21, the lake is fifty per cent. larger.

On July 14, the boiling pit has filled up 25 feet in the previous fortnight.

By the middle of August the lava reached the elevation of about 150 feet below the rim, supplied from a small area upon one side called "Old Faithful." The part most remote from the fountain cooled, and thus was built up a structure like an inverted saucer; but this rim would give way and allow a stream of the lava to even up the surface. Dr. N. B. Emerson thus describes "Old Faithful":

"A jet of lava appears:—scales are sucked down around it. This swells up as one huge, rotund, white hot mass leaping high into the air for many seconds and then subsides as if there were a connection with a fire shaft deep in the earth's interior."

There are other similar jets in other quarters and near the edge. The surface becomes encrusted, lines of fire like the arms of Octopus traverse the darker areas and break up the ice into fragments, which tip over, sink, and disappear. Waves dash against the walls of the pit like surf against cliffs.

By September 4, the lava attained its highest level, about 100 feet below the rim, when a discharge took place just like the eruptions of earlier dates. The fountains ceased to play; the lake began to sink in the centre; the liquid began to pour as cataracts of fire into a chasm, like water pouring into a funnel. As the torrents drained away the sides of the pit began to crash into the lake, hundreds of tons of rock peeled off the sides, stones crunched and when heated exploded with terrifying detonations. It took two hours for this collapse to be effected. Everything that had filled the pit for nearly 1,000 feet drained away, and the next day the volcano was dead.

On the evening of September 6, a spark of fire appeared 500 feet down, the lava returned, and in about the same time required for the discharge, the pit was filled again to 150 feet below its original level. "Old Faithful" and the other jets and currents played as before. Coincident with the collapse there were earthquakes in Hilo and Puna, the most severe occurring on Sept. 5. Those who had memories of the great shocks of 1868 believed these later quakes to have been as vigorous as those of the earlier date. Great damage was done to china and earthenware, but buildings were not particularly shattered.

The lava returned to stay. The records of the fall and winter

repeat the conditions that have been already described previous to the collapse.

The conditions from December 3 to 11, as I observed them, were these: The lake was estimated to be 350 feet long and half as wide. The jagged fire-lines, as before, shattered the encrusted surface into fragments, which sank and disappeared. The action of the liquid was like that of ebullition. Near the boiling area there was a movement estimated to be as much as five miles per hour. From a hole in one of the walls a stream of lava would occasionally pour into the gulf. The spatter work reminded one of gold leaf. Pele's hair* was forming constantly. The level of the lake is variable. Three black ledges are apparent at different levels.



FIG. 2--KILAUEA. ERUPTION OF 1908.

Early in February Mr. E. D. Baldwin, a competent engineer, found the level of the liquid lava to have been 235 feet below the edge of the pit. And judging from the reports of visitors, the conditions did not materially change through March and April. The conditions of the last two years remind one of the eruption of 1879. For many months Halemaumau had been in an active state, and the bottom dropped out on April 21. Seven days later it was reported to be almost extinct. By June 24, two lakes were active, just as they had been before, and they subsequently became one. For several years afterwards most visitors were privileged to witness interesting evidences of the presence of Pele.

* Hair of Pele, Goddess of Kilauea. Applied to lava of this volcano which, while fused, is blown by the wind into long delicate fibers.—EDITOR.

Fig. 2 is a photograph of the bottom of the pit taken about August, 1908. As the camera had to be placed about 200 feet above the lava, the whole of the lake could not be shown. The black ledge makes the steep bank in the distance. Three of the fire fountains appear next that wall very much like spray. Near the front is an irregularly shaped floating island of rock at whose edges is this fountain called "Old Faithful." The darker areas generally are the congealed crust. Next to the outside border the edge of liquid is apparent, always more conspicuous when the lake is sinking.

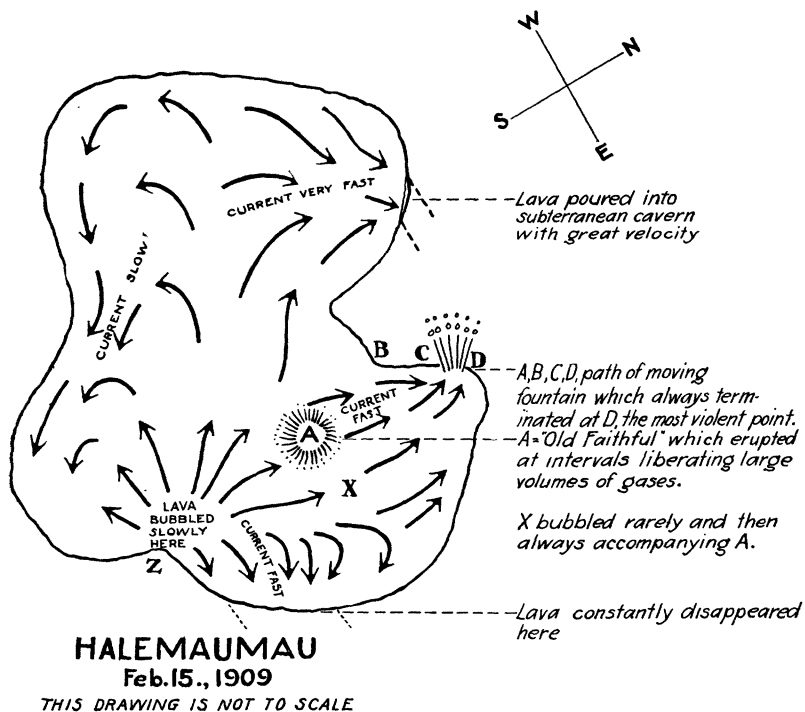


FIG. 3.

The long fascicles of lighter shade are fire lines which are developed by the photographer; I did not recognize them when looking down into the pit.

Early in the present year Bruce Cartright, Jr., of Honolulu, took observations of the action of "Old Faithful" in ten-minute periods, and kindly allows us the use of his diagram. First is a sketch map (Fig. 3) of the lake itself, showing the positions of the fountains, and the arrows indicate the directions of the currents and their condition of activity. At the northeast, the lava poured into a sub-

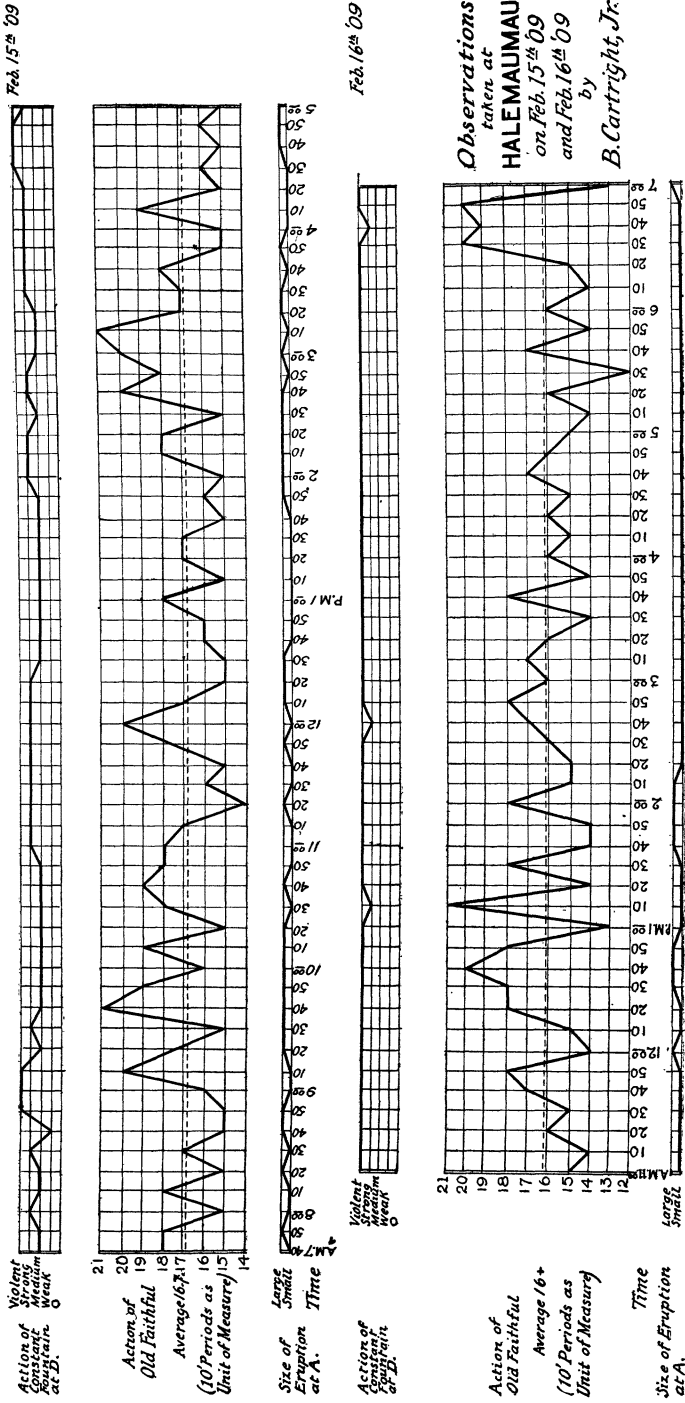


FIG. 4.

terranean cavity with great velocity. A, B, C, D indicate the path of a moving fountain, which always terminated at D, the most violent point. A is the place of "Old Faithful," erupting at the intervals to be specified, liberating large volumes of gas or steam. At X there was a bubbling of similar character, always accompanying A to the right of Z, where the lava was constantly disappearing.

The second diagram (Fig. 4) indicates graphically the number of eruptions in periods of ten minutes for nine hours upon February 15, and eight hours the following day. The maximum number was 21 and the minimum 12, with the average of 16+ and 16.7+.

It is the first time that any attempt has been made to record the number and intensity of these outbursts, and the diagram may illustrate one of the class of observations that will be made when the Seismological Observatory shall be established at this locality.

RAILROADS IN ASIA MINOR.

BY

ELLSWORTH HUNTINGTON.

The year 1909 has been characterized by an important renewal of railroad building in Asia Minor. In addition to far-reaching plans, which are as yet only under discussion, there are other plans which are in actual process of accomplishment. The plans under discussion provide for a railroad which shall start on the Black Sea, presumably at Samsun, and go southward across the central plateau to Sivas, about 4,500 feet above the sea, and then southeast to Diarbekr at the southern foot of the plateau, whence it will continue into Mesopotamia to join the long-talked-of Baghdad Railway. From Sivas branches will run east and west along the plateau. The special object in view is to reach the rich mines of copper, silver and other minerals which might be worked to great advantage if transportation facilities were provided. An American company has offered to finance the undertaking with no other guarantee than the right to work all the mines along the zone within easy reach of the proposed railroad.

Far more definite than the plans mentioned above is the actual work now being accomplished upon the Baghdad and Dineir Railways. At the present day three railroads, financed by German, French and English companies, respectively, run up the long east